

WHAT WE CLAIM IS:

1. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

an H-plane antenna is provided on a plasma head, slots of said H-plane slot antenna are arranged alternately on both sides of the centerline of the waveguide with a pitch of $\lambda_g/2$ (λ_g : guide wavelength of microwave), and a uniforming line is provided with a distance from said slot to emission end of said plasma head being set to $n \cdot \lambda_g/2$ (where n represents an integral number).

2. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

an E-plane antenna is provided on a plasma head, slots of said E-plane slot antenna are arranged along the centerline of the waveguide with a pitch of λ_g (λ_g : guide

wavelength of microwave), and a uniforming line is provided with a distance from said slot to emission end of said plasma head being set to $n \cdot \lambda g/2$ (where n represents an integral number).

3. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of a material with high dielectric constant to reduce the standing wave in the plasma head.

4. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of quartz, an end portion thereof is extended by $1/4\lambda$ (where λ represents free space wavelength within the quartz) to reduce the standing wave

in the plasma head.

5. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, an electromagnetic wave absorbing material with high dielectric loss is attached on an end of said uniforming line to reduce the standing wave in the plasma head.

6. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by down-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

7. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or

under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by side-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

8. A microwave plasma processing method for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a shield gas feeding pipe is connected for feeding a shield gas to the plasma head, a resistance plate for carrying out uniform feeding of the shield gas into the plasma processing chamber on downstream side of the shield gas feeding pipe is arranged, and a resistance plate for homogeneous discharge of the gas is provided on discharge side.

9. A microwave plasma processing method according to claim 8, wherein gas shielding is provided in such manner that pressure P_1 in said plasma processing chamber is set to a value lower than pressure P_3 on the outermost

periphery of said plasma head, pressure P_3 is set to a value lower than the pressure P_2 near the resistance plate for carrying out uniform gas discharge, and that the leakage of the gas from the plasma head is prevented.

10. A microwave plasma processing method according to one of claims 1 to 9, wherein said microwave plasma processing method is a microwave plasma CVD processing method.

11. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein;

an H-plane antenna is provided on a plasma head, slots of said H-plane antenna are arranged alternately on both sides of the centerline of the waveguide with a pitch of $\lambda_g/2$ (λ_g : guide wavelength of microwave), and a uniforming line is provided with a distance from said slot to the emission end of said plasma head being set to $n \cdot \lambda_g/2$ (where n represents an integral number).

12. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or

under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein;

an E-plane antenna is provided on a plasma head, slots of said E-plane antenna are arranged along the centerline of the waveguide with a pitch of λ_g (λ_g : guide wavelength of microwave), and a uniforming line is provided with a distance from said slot to the emission end of said plasma head being set to $n \cdot \lambda_g/2$ (where n represents an integral number).

13. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of a material with high dielectric constant to reduce the standing wave in the plasma head.

14. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the

object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of quartz, an end portion thereof is extended by $1/4\lambda$ (where λ represents free space wavelength within the quartz) to reduce the standing wave in the plasma head.

15. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, an electromagnetic wave absorbing material with high dielectric loss is attached on an end of said uniforming line to reduce the standing wave in the plasma head.

16. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal

position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by down-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

17. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by side-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

18. A microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a shield gas feeding pipe is connected for feeding a shield gas to the plasma head, a resistance plate for carrying out uniform feeding of the shield gas into the plasma processing chamber on downstream side of the shield

gas feeding pipe is arranged, and a resistance plate for homogeneous discharge of the gas is provided on discharge side.

19. A microwave plasma processing apparatus according to claim 18, wherein gas shielding is provided in such manner that pressure P_1 in said plasma processing chamber is set to a value lower than pressure P_3 on the outermost periphery of said plasma head, pressure P_3 is set to a value lower than the pressure P_2 near the resistance plate for carrying out uniform gas discharge, and that the leakage of the gas from the plasma head is prevented.

20. A microwave plasma processing apparatus according to one of claims 11 to 19, wherein said microwave plasma processing method is a microwave plasma CVD processing method.

21. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein;

an H-plane antenna is provided on a plasma head, slots of said H-plane antenna are arranged alternately on both

sides of the centerline of the waveguide with a pitch of $\lambda_g/2$ (λ_g : guide wavelength of microwave), and a uniforming line is provided with a distance from said slot to the emission end of said plasma head being set to $n \cdot \lambda_g/2$ (where n represents an integral number).

22. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein;

an E-plane antenna is provided on a plasma head, slots of said E-plane antenna are arranged along the centerline of the waveguide with a pitch of λ_g (λ_g : guide wavelength of microwave), and a uniforming line is provided with a distance from said slot to the emission end of said plasma head being set to $n \cdot \lambda_g/2$ (where n represents an integral number).

23. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is

being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of a material with high dielectric constant to reduce the standing wave in the plasma head.

24. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, said uniforming line is made of quartz, an end portion thereof is extended by $1/4\lambda$ (where λ represents free space wavelength within the quartz) to reduce the standing wave in the plasma head.

25. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be

processed at horizontal position with respect to said linear plasma, wherein:

a uniforming line is provided on the plasma head, an electromagnetic wave absorbing material with high dielectric loss is attached on an end of said uniforming line to reduce the standing wave in the plasma head.

26. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by down-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

27. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a film-deposition gas is passed to surface of said object to be processed by side-flowing through a film-deposition gas feeding nozzle arranged in the plasma head.

28. A plasma head of a microwave plasma processing apparatus for forming linear plasma by using microwave and for processing an object to be processed under the atmospheric pressure or under a pressure near the atmospheric pressure when the object to be processed is being moved by maintaining the surface of the object to be processed at horizontal position with respect to said linear plasma, wherein:

a shield gas feeding pipe is connected for feeding a shield gas to the plasma head, a resistance plate for carrying out uniform feeding of the shield gas into the plasma processing chamber on downstream side of the shield gas feeding pipe is arranged, and a resistance plate for homogeneous discharge of the gas is provided on discharge side.

29. A plasma head of a microwave plasma processing apparatus according to claim 28, wherein gas shielding is provided in such manner that pressure P_1 in said plasma processing chamber is set to a value lower than pressure P_3 on the outermost periphery of said plasma head, pressure P_3 is set to a value lower than the pressure P_2 near the resistance plate for carrying out uniform gas discharge,

and that the leakage of the gas from the plasma head is prevented.

30. A plasma head of a microwave plasma processing apparatus according to one of claims 21 to 29, wherein said microwave plasma processing apparatus is a microwave plasma CVD processing apparatus.

31. A method for manufacturing FPD or a semiconductor device, characterized in that the product is manufactured by the microwave plasma processing method according to claim 1.